

1/15

15/1  
36/8

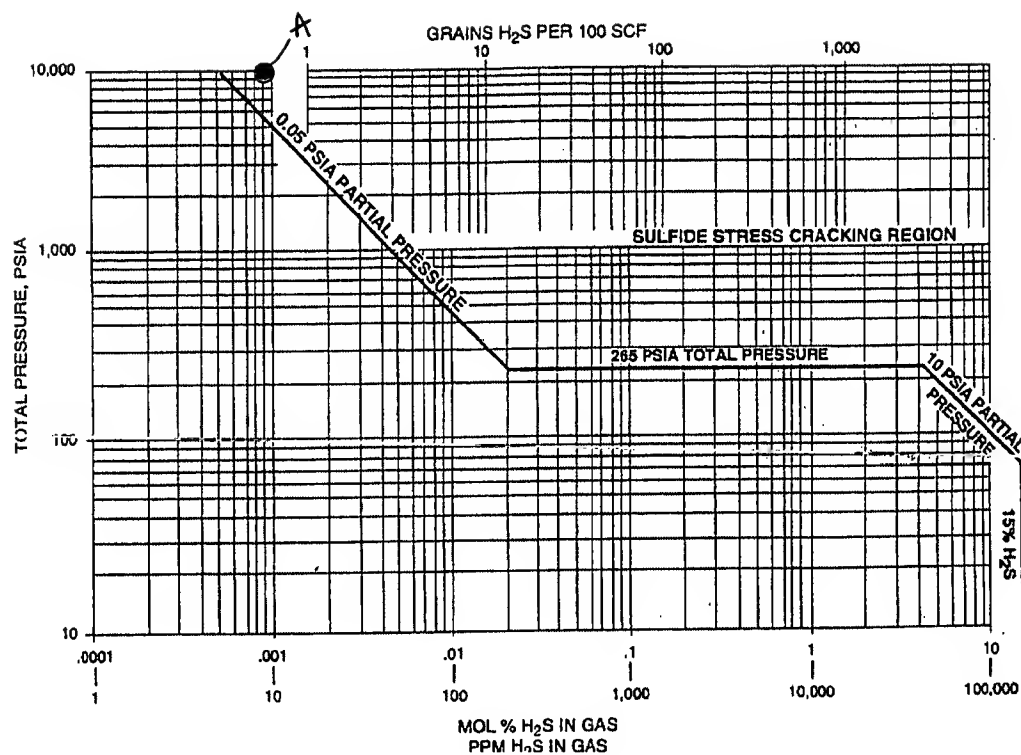


Fig. 1

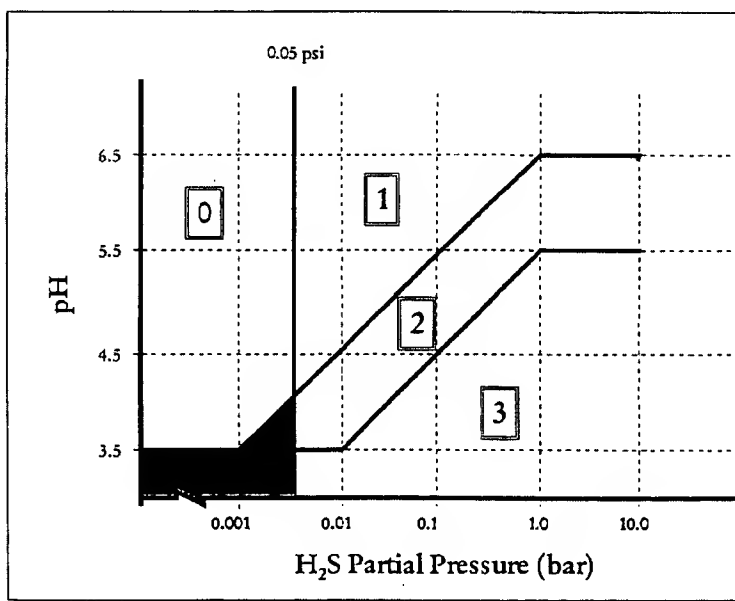


Fig. 2

0994199-112601

RAW MATERIAL BAR STOCK	
ALLOY	\$/lb.
4130	1.0
4140	1.0
9Cr	1.5
410-13Cr	2.0
420 Mod.	2.0
17-4	3.0
304	2.5
316	3.0
S13Cr	5.0
450	6.0
918	5.5
Monel K-500	12
925	11.5
718	12
625M	20
725	20
C-276	50
MP35N	60

Fig. 3

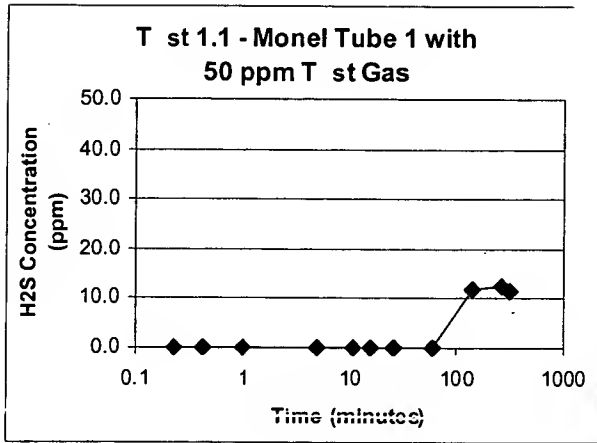


Fig. 4

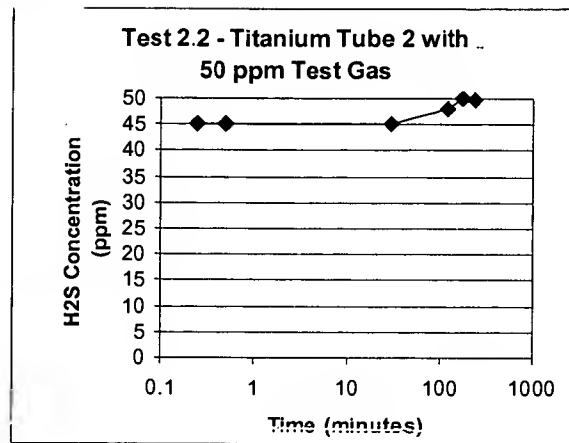


Fig. 5

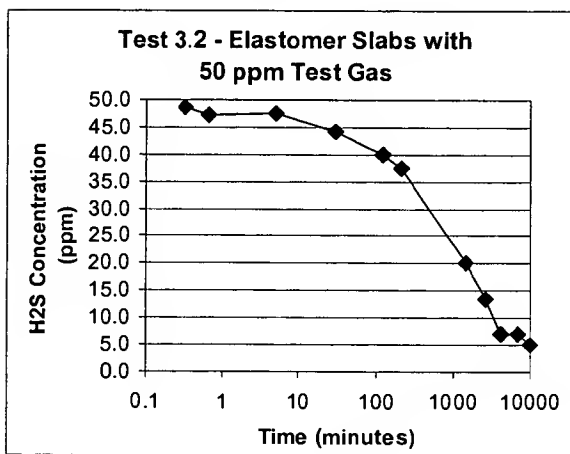


Fig. 6

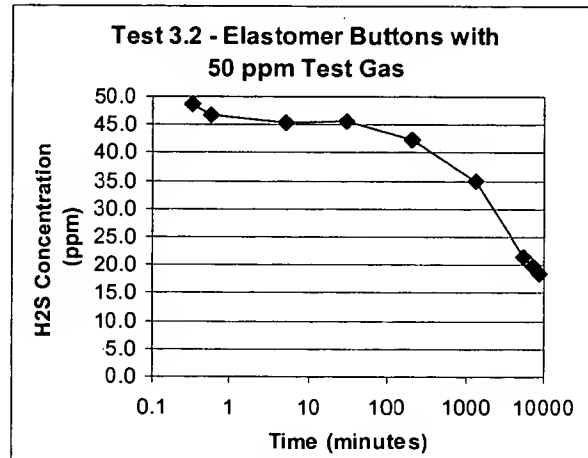


Fig. 7

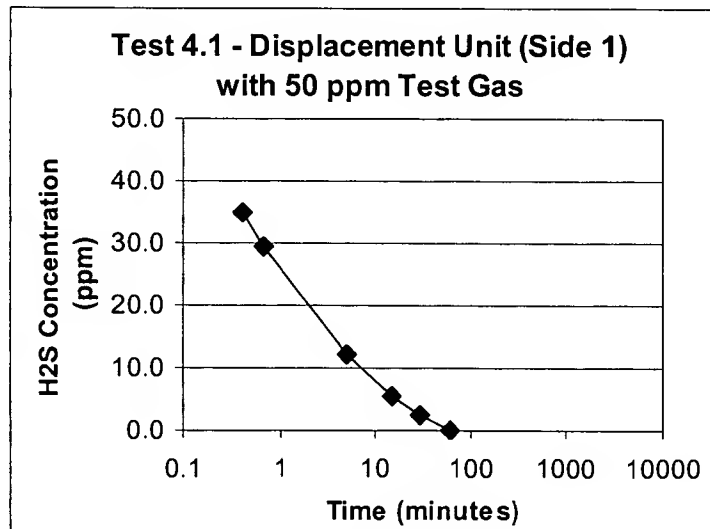


Fig. 8

4/5

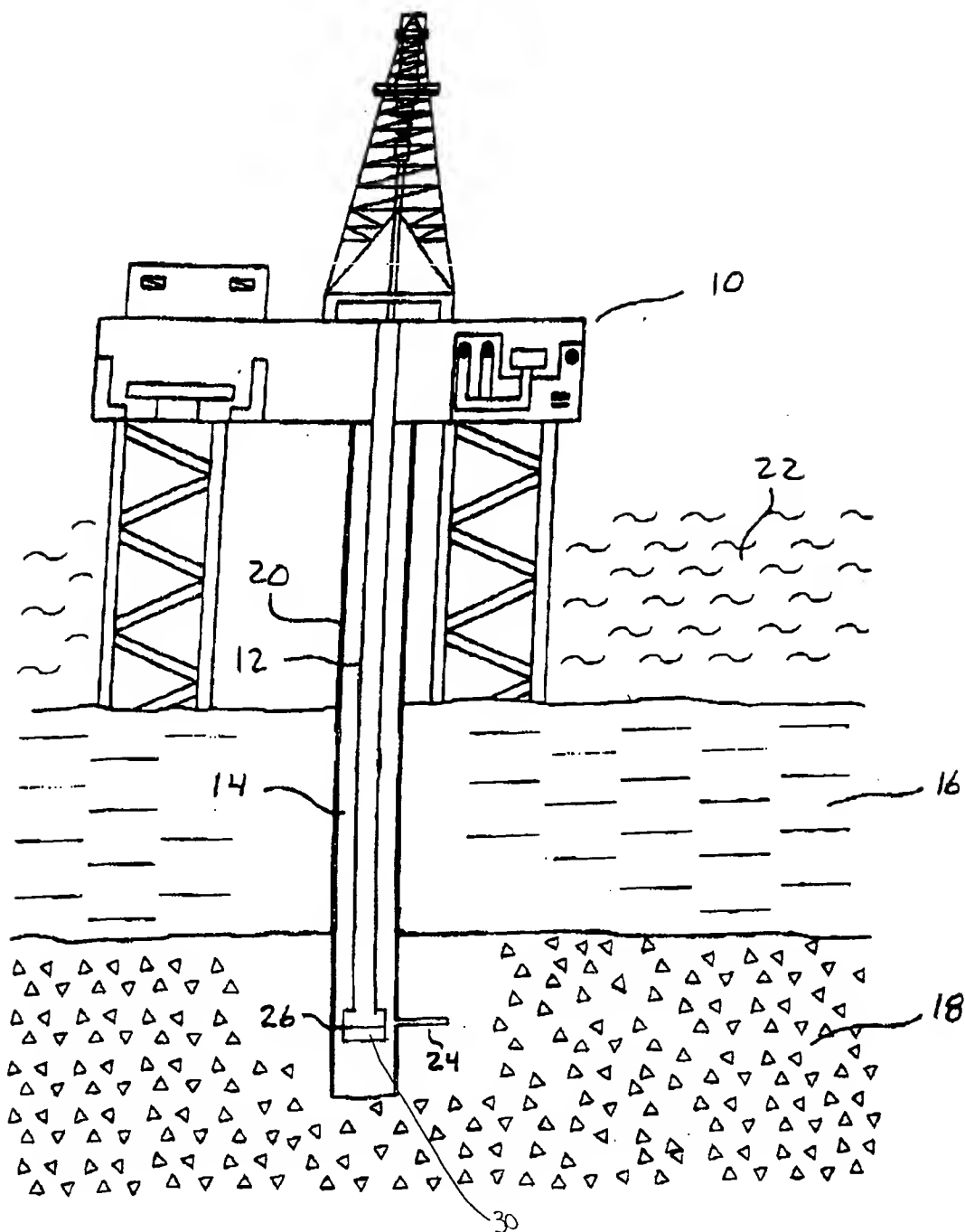


FIG. 9

09944-199-112601

5/15

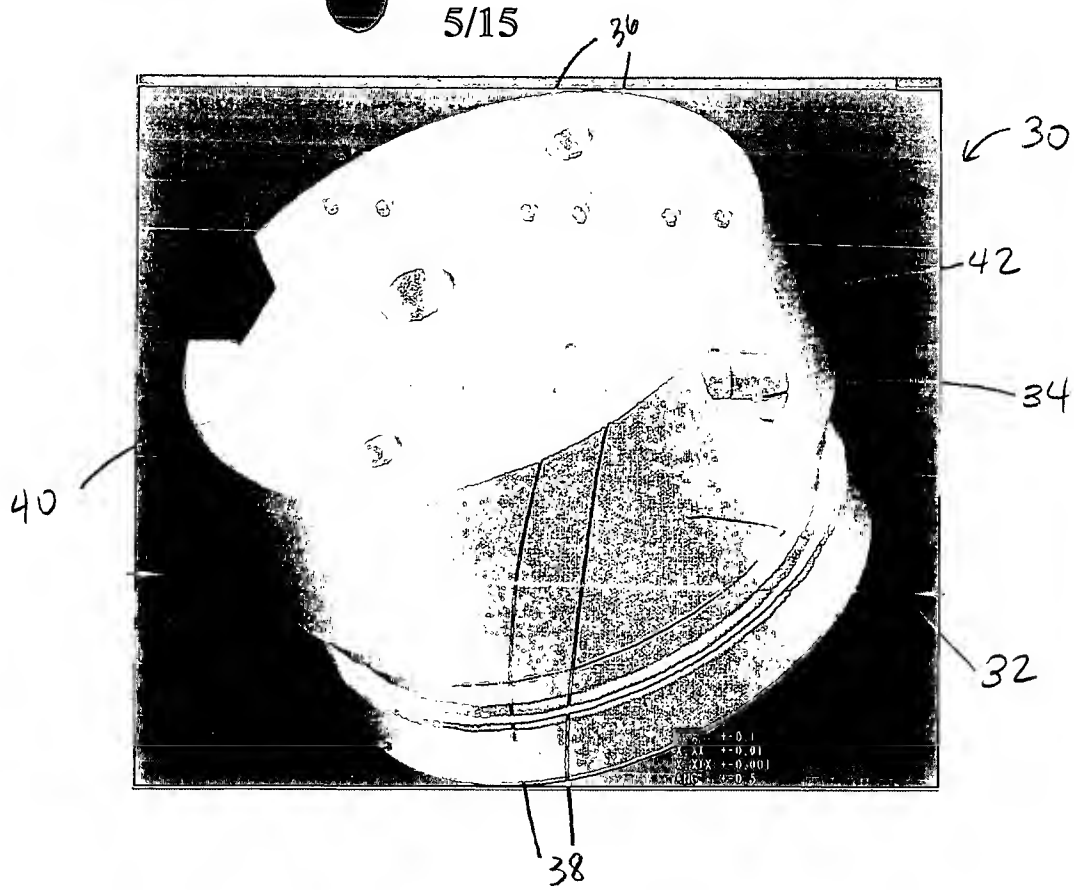


Fig. 10

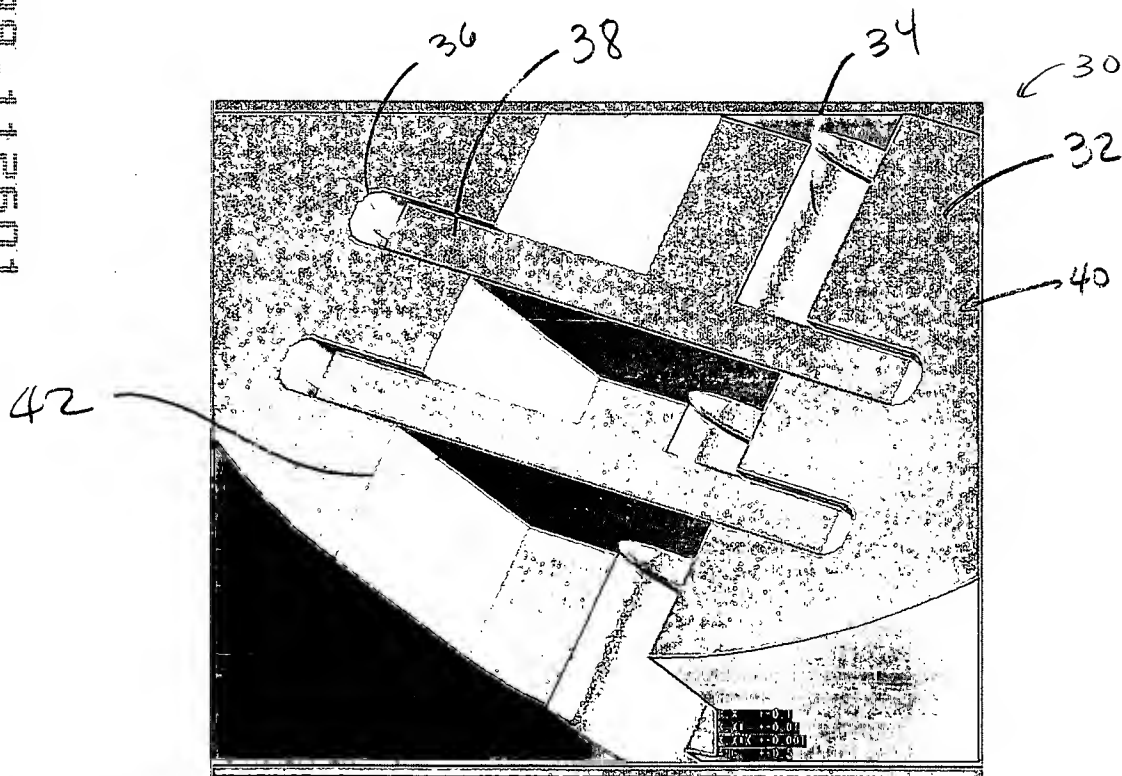


Fig. 11

09994199-112601

u/s

Figure 12

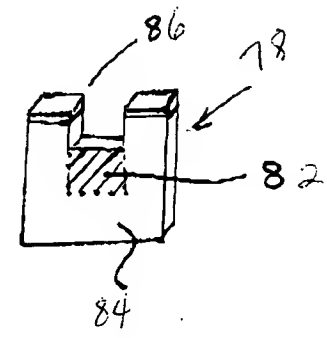
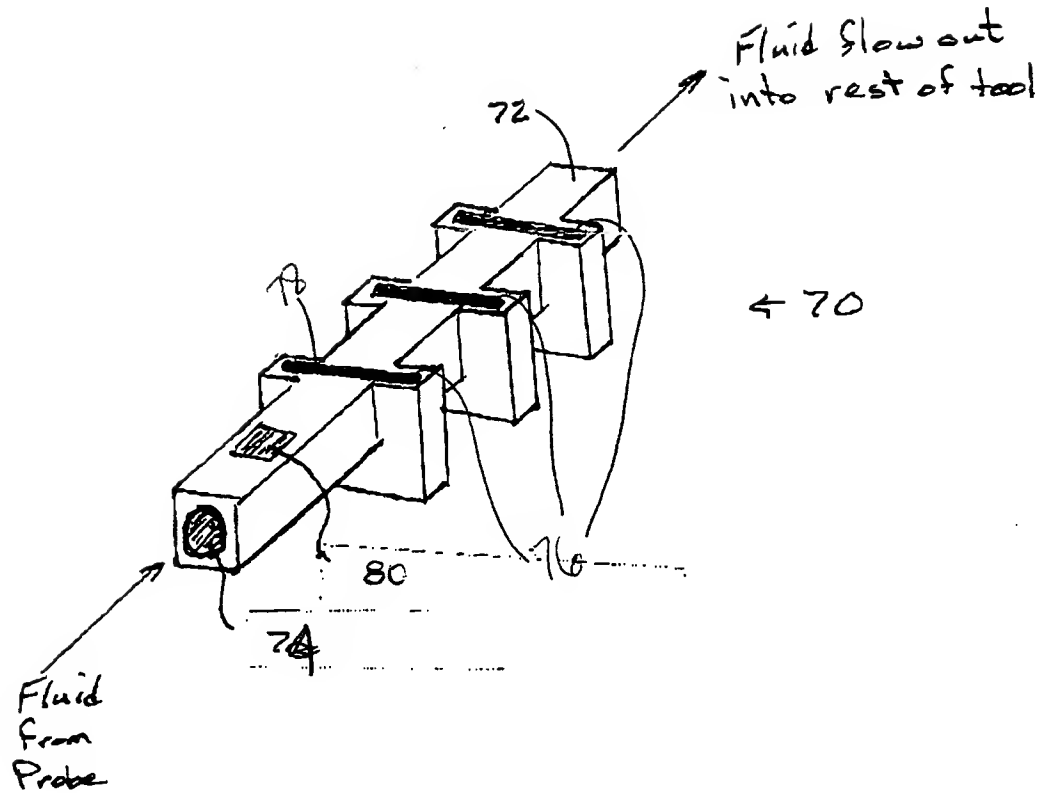


FIG. 13

FIG. 12

7/5

FIG. 14

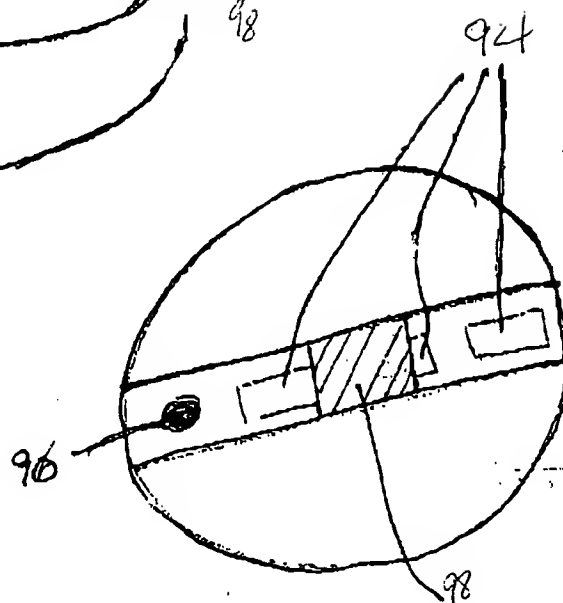
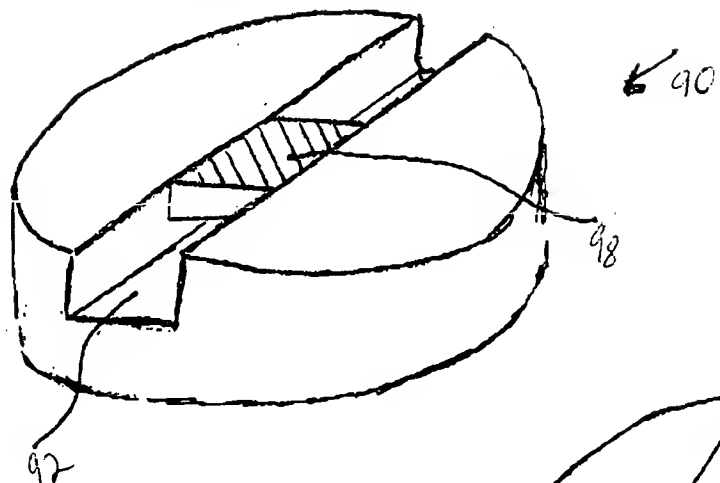


FIG. 15

109277-6674660

**Fig. 16 – LIST OF MATERIALS TESTING IN THIS STUDY**

(Nominal Composition in wt. Percent)					
<i>Alloy</i>	<i>Ni</i>	<i>Cu</i>	<i>Fe</i>	<i>Cr</i>	<i>Mo</i>
<i>Monel alloy</i> <i>400</i> <i>N04400</i>	63 – 70	Bal.	2.5 max.	--	--
<i>70-30</i> <i>cupronickel</i> <i>C71500</i>	29 – 33	Bal.	0.4 – 1.0	--	--
<i>90-10</i> <i>cupronickel</i> <i>C70600</i>	9 – 11	86.5 min.	1.0 – 1.8	--	--
<i>Nickel alloy</i> <i>200</i> <i>N02200</i>	99.0 min.	0.25 max.	0.40 max.	--	--
<i>Alloy B</i> <i>N10001</i>	Bal.	--	6.0 max.	1.0 max.	26 – 33
<i>Incoloy alloy</i> <i>600</i> <i>N06600</i>	72 min.	.50 max.	6 - 10	14 - 17	--
<i>5Cr steel</i> <i>K41545</i>	--	--	Bal.	4 - 6	0.45 – 0.65
<i>9Cr steel</i> <i>K90941</i>	--	--	Bal.	8 - 10	0.9 – 1.1
<i>12Cr steel</i> <i>S41000</i>	--	--	Bal.	11.5 – 13.5	--

10321 " 65F4660



**Fig. 17 – RESULTS FROM PHASE I TESTS**

<i>Test No.</i>	<i>H<sub>2</sub>S (ppm)</i>	<i>Duration (hr.)</i>	<i>Temp. (F)</i>	<i>Monel 400</i>	<i>70/30 CuNi</i>	<i>90/10 CuNi</i>	<i>Ni 200</i>	<i>Alloy 600</i>	<i>Alloy B</i>
Condition of Coupons after Exposure									
1*	0	6	250	O	O	ST	--	--	--
2*	0	2	400	O	ST	ST	--	--	--
3	0	2	250	ST	ST	ST	--	--	--
4	50	2	250	G	DG	DG	--	--	--
5	0	2	300	ST	ST	ST	--	--	--
6	50	2	300	DG	G	DG	--	--	--
7	0	2	350	ST	ST	ST	--	--	--
8	50	2	350	DG	G	DG	--	--	--
9	0	2	400	ST	ST	ST	--	--	--
10	50	2	400	DG	G	G	--	--	--
11	25	2	300	DG	G	DG	--	--	--
12	25	6	300	DG	G	G	--	--	--
13	10	2	300	DG	G	G	--	--	--
14	10	2	300	DG	G	DG	--	--	--
15	5	2	300	DG	G	G	--	--	--
16	25	2	300	DG	G	DG	G	ST	DG
17	10	2	300	DG	G	DG	ST	ST	ST
18	18	2	300	DG	G	G	ST	ST	G

Note:

O – No attack

ST – Slight tarnish

G – Gray corrosion film

DG – Dark gray corrosion film

\* Test contained oil mud as liquid phase

T0921 " 654550

10/15

**Fig. 18 - RESULTS FROM PHASE II TESTS**

<i>Test No.</i>	<i>H<sub>2</sub>S (ppm)</i>	<i>Duration (hr.)</i>	<i>Temp. (F)</i>	<i>5Cr</i>	<i>9Cr</i>	<i>12Cr</i>	<i>316 SS</i>	<i>Ni 200</i>	<i>Alloy 600</i>	<i>Alloy B</i>
Condition of Coupons after Exposure										
201*	25	2	250	G	G	G	O	DG	T	B
301*	50	2	250	G	G	G	O	G	T	G
401	25	2	250	G	G	G	G	G	G	DG
501	50	2	250	DG	DG	G	LG	G	G	DG
601	100	2	250	DG/B	DG/B	DG/B	LG	LG	B	G
701	50	2	250	DG	DG	B	LG	G	G	LG
801	75	2	250	DG	DG	DG	LG	LG	DG	G
901	100	2	300	DG	DG	DG	LG	LG	B	G
1001	75	2	300	DG	G	DG	LG	LG	B	G
1101	50	2	300	DG	DG	DG	LG	LG	B	G
1201	100	2	250	DG	DG	DG	G	G	BB	G
1301	75	2	300	G/B	G/B	G/B	G	G	B	G
1401	50	2	350	DG	DG	DG	G	G	DG	G
1501	75	2	350	DG	DG	G	G	LG	G	DG
1601	100	2	350	G/B	DG	DG	G	G	G	G

Note:

O – No attack

ST – Slight tarnish

LG – Light gray corrosion film

G – Gray corrosion film

DG – Dark gray corrosion film

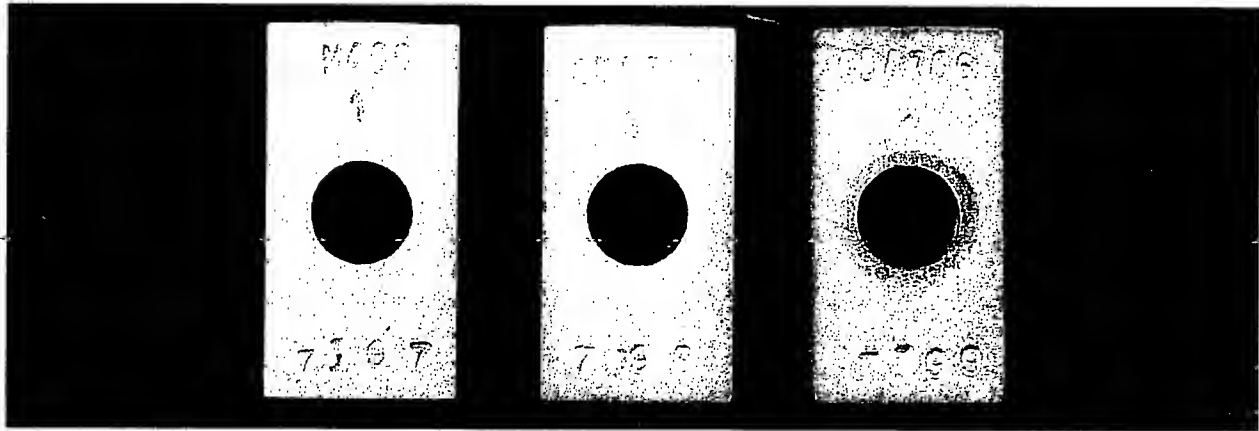
B – Black corrosion film

\* coupons in vapor phase

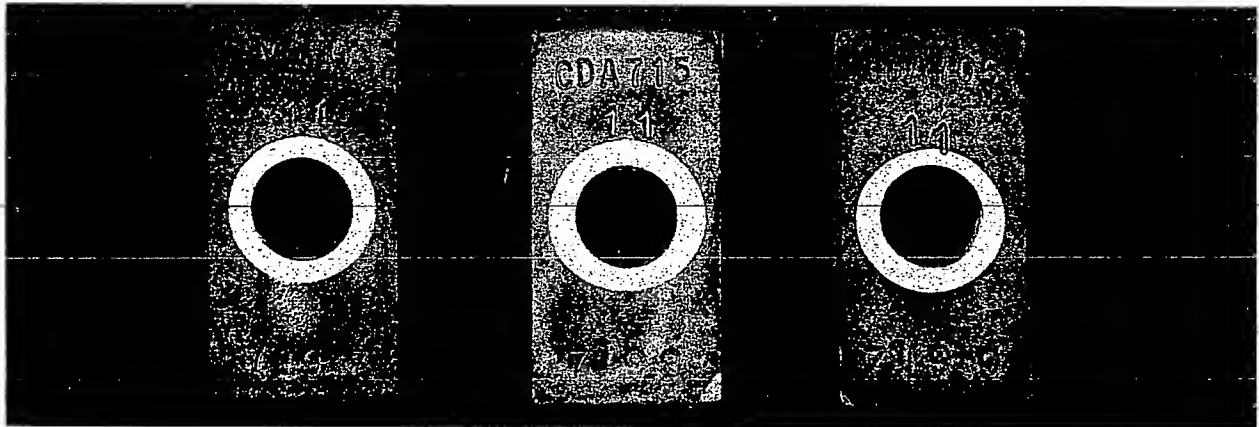
T.O. 921 F " 6674650

11/15

## Photo Summary of H<sub>2</sub>S Coupon Study



**Fig. 19A** Example of copper containing specimens with tarnish films from exposure – note darkening of surface while retaining shiny metallic luster



**Fig. 19B** Example of gray-black corrosion films on copper containing alloys – note dark surface films with no metallic luster

10927" 66746660

12/15

Change in Corrosion films on Monel with  
increasing levels of H<sub>2</sub>S in environment



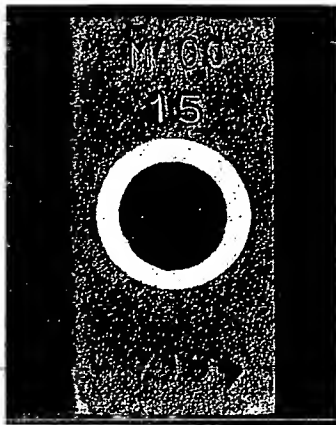
0 ppm H<sub>2</sub>S

Fig. 20A



25 ppm H<sub>2</sub>S

Fig. 20D



5 ppm H<sub>2</sub>S

Fig. 20B



50 ppm H<sub>2</sub>S

Fig. 20E



10 ppm H<sub>2</sub>S

Fig. 20C

Change in coloration from tarnish to dark  
gray between 5 and 10 ppm

0994199-11601  
T092T" 65F76560

Change in corrosion films on Alloy B with  
increasing levels of H<sub>2</sub>S in environment

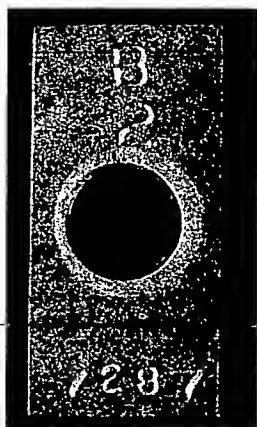


Fig. 21A

10 ppm H<sub>2</sub>S



Fig. 21D

50 ppm H<sub>2</sub>S

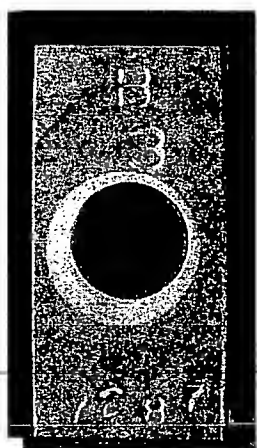


Fig. 21B

18 ppm H<sub>2</sub>S

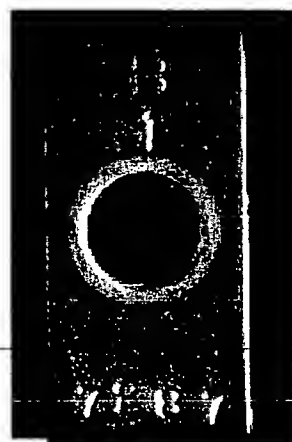


Fig. 21E

75 ppm H<sub>2</sub>S

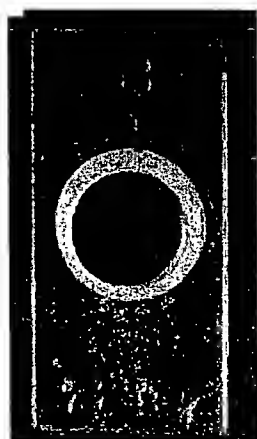


Fig. 21C

25 ppm H<sub>2</sub>S

Change in coloration from tarnish to gray  
between 18 and 25 ppm

Change in corrosion films on Alloy 600 with increasing levels of H<sub>2</sub>S in environment

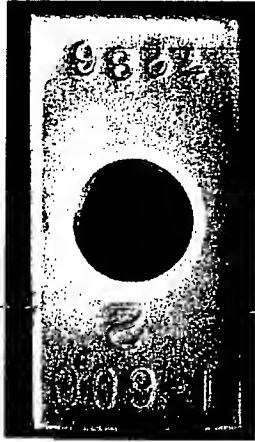


Fig. 22A 10ppm H<sub>2</sub>S

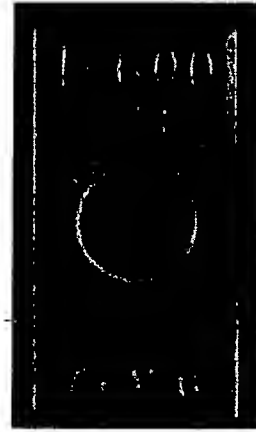


Fig. 22D 75 ppm H<sub>2</sub>S

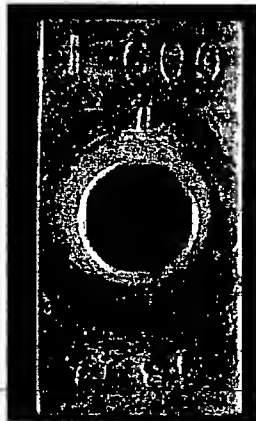


Fig. 22B 25 ppm H<sub>2</sub>S



Fig. 22E 100 ppm H<sub>2</sub>S



Fig. 22C 50 ppm H<sub>2</sub>S

Change in coloration from tarnish to brown/gray black between 25 and 50 ppm

10922T-66T45660

15/15

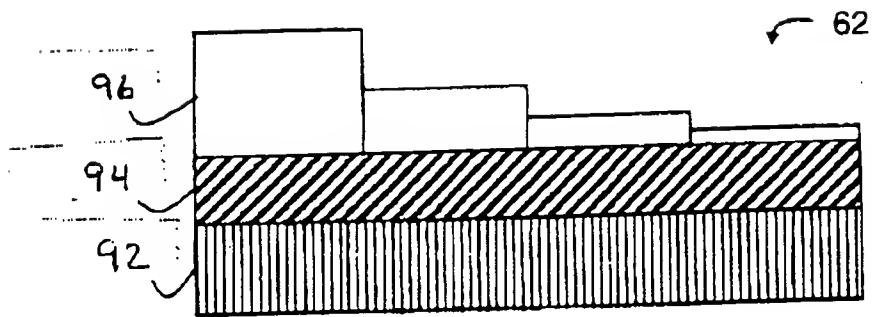


FIG. 23

FOOTPRINT 65746660